UNIVERSIDADE FEDERAL DOS VALES DO JEQUITINHONHA E MUCURI
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EFEITOS ADICIONAIS DE EXERCÍCIOS PARA O CORE NA MELHORA DA DOR E DA CAPACIDADE FUNCIONAL RELACIONADA A SÍNDROME DA DOR PATELOFEMORAL: REVISÃO SISTEMÁTICA DE ENSAIOS CLÍNICOS CONTROLADOS RANDOMIZADOS

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“A menos que modifiquemos a nossa maneira de pensar, não seremos capazes de resolver os problemas causados pela forma como nos acostumamos a ver o mundo.”

Albert Einstein

“A curiosidade é mais importante do que o conhecimento.”

Albert Einstein

RESUMO

INTRODUÇÃO: a síndrome da dor femoropatelar (SDFP) é uma condição que afeta o joelho e resulta em dor peri ou retropatelar, com sintomas que geralmente pioram durante as atividades com descarga de peso (CROSSLEY, et al., 2016). Seu início está relacionado à influência de fatores locais, proximais e distais à articulação femoropatelar (AMERICAN PHYSICAL THERPY ASSOCIATION, 2019). A fraqueza dos músculos do core é um fator proximal descrito na literatura como um potencial contribuinte para maior sobrecarga da articulação femoropatelar em pacientes com SDFP (NAKAGAWA, 2012). Estudos prévios verificaram um atraso no recrutamento dos músculos do core em indivíduos com SDFP em resposta a um distúrbio externo e destacaram a importância do controle e da coordenação dos músculos do tronco para a capacidade funcional de indivíduos com essa condição (MOTEALLEH, et al, 2014). Embora a diferença no padrão de ativação dos músculos do core tenha sido identificada em indivíduos com SDFP, o papel que o fortalecimento desses músculos pode desempenhar no tratamento da SDFP ainda não está claro. **OBJETIVO:** investigar os efeitos da adição de exercícios para o core aos cuidados usuais na intensidade da dor e na capacidade funcional de indivíduos com SDFP. **MÉTODOS:** trata-se de uma revisão sistemática com metanálise de ensaios clínicos controlados randomizados, pesquisados nos bancos de dados Cochrane Database, AMED, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, EMBASE, MEDLINE, PSYCINFO, SPORTDISCUS, CINAHL e PEDro até 9 de setembro de 2020. Dois revisores independentes avaliaram os estudos que incluíram a adição de exercícios para o core aos cuidados usuais e compararam com os efeitos dos cuidados usuais isolados em pacientes com SDFP. Os desfechos de interesse foram a intensidade da dor e o nível de capacidade funcional. A avaliação da qualidade metodológica e do risco de viés foi realizada através da escala PEDro. As diferenças entre as médias (MD), ou quando agrupando dados de diferentes escalas, diferenças médias padronizadas (SMD) foram calculadas através de modelos de efeito fixo com intervalos de 95% (IC) para desfechos contínuos. A interpretação dos resultados foi orientada pelo sistema Grading of

Recommendations Assessment, Development and Evaluation (GRADE). **RESULTADOS:** cinco estudos de moderada a alta qualidade metodológica preencheram os critérios de inclusão. Houve evidência de baixa certeza de que adicionar exercícios para o core ao tratamento usual é superior ao tratamento usual isolado para melhorar a intensidade da dor (MD = 1.93; 95% CI: 1.28 to 2.57) e capacidade funcional (MD= 6.45; 95% CI: 3.47 to 9.43) em adultos com SDFP no curto prazo. Houve evidência limitada de que um protocolo de reabilitação de quadril e core foi superior a uma reabilitação de joelho para melhorar a intensidade da dor e a capacidade funcional em adultos com SDFP no curto prazo. **CONCLUSÃO:** adicionar exercícios para o core aos cuidados usuais melhorou a dor e a capacidade funcional em adultos com SDFP quando comparado com o resultado dos cuidados usuais isolados no curto prazo, no entanto, devido ao baixo nível de certeza da evidência, os resultados devem ser interpretados com cautela.

Palavras-chave: Dor Patelofemoral. Trunk. Incapacidade Funcional. Fisioterapia. Biomecânica.

ABSTRACT

BACKGROUND: Patellofemoral pain syndrome (PFPS) is a condition that affects the knee and results in peri- or retropatellar pain, with symptoms that generally worsen during weight-bearing activities (CROSSLEY, et al., 2016). Its beginning is related to the influence of local, proximal and distal factors to the patellofemoral joint (AMERICAN PHYSICAL THERPY ASSOCIATION, 2019). Core muscle weakness is a proximal factor described in the literature as a potential contributor to greater patellofemoral joint overload in PFPS patients (NAKAGAWA, 2012). Previous studies found a delay in core muscle recruitment in individuals with PFPS in response to an external disorder and highlighted the importance of control and coordination of trunk muscles for the functional ability of individuals with PFPS (MOTEALLEH, et al, 2014). Although the difference in the pattern of activation of core muscles in individuals with PFPS is known, the role that strengthening these muscles can play in the treatment of PFPS remains unclear. **OBJECTIVE:** to investigate the effects of adding core exercises to usual care on pain intensity and functional ability of individuals with PFPS. **METHODS:** this is a systematic review with meta-analysis of randomized controlled clinical trials, searched in the Cochrane Database, AMED, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, EMBASE, MEDLINE, PSYCINFO, SPORTDISCUS, CINAHL and PEDro until September 9. Two reviewers independently evaluated studies that included the addition of core exercises to usual care and compared it with the effects of usual care alone in patients with PFPS. Outcomes of interest were pain intensity and level of functional ability. The assessment of methodological quality and risk of bias was performed using the PEDro scale. Differences between means (MD), or when grouping data from different scales, standardized mean differences (SMD) were calculated using fixed effect models with 95% intervals (CI) for continuous outcomes. The interpretation of the results was guided by the system of Grading of Recommendations Assessment, Development and Evaluation (GRADE). **RESULTS:** Five studies of low to high methodological quality met the inclusion criteria. There was low certainty evidence that adding core exercises to usual care is superior to usual care alone for improving pain intensity (MD = -1.85; 95% CI: -2.34 to -1.35 fixed effects) and functional ability (MD = 6.11; 95% CI: 3.97 to 8.26) in adults with PFPS. There was limited evidence that a hip and core rehabilitation protocol was superior to a knee rehabilitation protocol for improving pain intensity and

functional ability in adults with PFPS. **CONCLUSION:** adding core exercises to usual care improved pain and functional ability in adults with patellofemoral pain compared to usual care alone in the short term, however, due to the low level of certainty, the results should be interpreted with caution.

Keywords: Anterior Knee Pain. Physical Therapy. Patellofemoral Pain. Knee. Rehabilitation. Pain. Physical Functional Performance.

SUMÁRIO

1 INTRODUÇÃO

A síndrome da dor femoropatelar (SDFP) consiste na presença de dor na região anterior no joelho de característica peri ou retropatelar, com exacerbação durante movimentos com descarga de peso, como subir escadas, caminhar, correr, ajoelhar, agachar e pular e ainda durante movimentos em cadeia cinética aberta como na extensão final resistida do joelho (PETERSEN, 2014). Sua natureza multifatorial está relacionada ao aumento da prática de atividade física em indivíduos jovens, alterações anatômicas, alterações biomecânicas, além de disfunções no controle neuromuscular do tronco, quadril e joelho (POWERS, 2003; POWERS, 2010; NAKAGAWA, 2012).

Considerada uma das condições de saúde que mais afetam a articulação do joelho, a prevalência da SDFP é estimada em 22.7% na população adulta e 28.9% entre adolescentes (SMITH, et al, 2018). Pode afetar pessoas em diferentes idades e níveis de atividade física, no entanto, é mais frequente em indivíduos fisicamente ativos, com idade entre 12 e 19 anos de idade, sendo ainda 2,2 vezes mais frequente em mulheres que em homens (AMERICAN PHYSICAL THERAPY ASSOCIATION, 2019).

Estima-se que um a cada dez indivíduos praticantes de atividade física desenvolvem a dor femoropatelar (WITVROUW *et al*., 2000; LEE *et al*., 2003; POWERS, 2003; 2010). Estudos apontam que a prevalência da SDFP chega a 36% entre praticantes de ciclismo profissional, 21% em praticantes de corrida do sexo feminino e a 16% em corredores do sexo masculino (COLLINS, et al, 2017; JOSPT, 2019). Dos praticantes de modalidades esportivas em geral, 74% de indivíduos com SDFP limitarão ou interromperão a participação no esporte devido aos seus sintomas dolorosos (MYER, et al, 2010).

Estudos verificaram a associação da redução do torque dos músculos do complexo posterolateral (CPL) do quadril e dos extensores do joelho com maior excursão do movimento de adução e rotação interna do quadril, bem como do aumento do momento abdutor do joelho, caracterizando o padrão de valgo dinâmico (DIERKS, *et al*, 2008; SOUZA E POWERS, 2009; BALDON, *et al*, 2011; JACOBS e MATTACOLA, 2005). O valgo dinâmico, por sua vez, pode resultar no aumento da pressão femoropatelar

durante a realização de movimentos funcionais com descarga de peso corporal (BLACKBURN e PÁDUA, 2009; POLLARD, SIGWARD, POWERS, 2010; BALDON, 2014). Em suma, tais alterações biomecânicas são descritas como um dos principais fatores associados aos sintomas de dor retro ou peripatelar durante atividades funcionais como corrida e subida de escadas (BALDON, 2014).

Segundo a última diretriz de prática clínica da American Physical Therapy Association (2019), a abordagem terapêutica tradicional recomendada a pacientes com SDFP contempla intervenções proximais, locais e distais. Exercícios de fortalecimento têm recomendação com nível A de evidência para os extensores e rotadores laterais do quadril – complexo posterolateral – bem como do quadríceps em cadeia cinética aberta e fechada (AMERICAN PHYSICAL THERAPY ASSOCIATION, 2019). O fortalecimento muscular é recomendado para o tratamento de pacientes com dor femoropatelar com base na suposição de que uma melhor atuação do quadríceps, bem como dos extensores e rotadores laterais do quadril possam contribuir para melhora do alinhamento dinâmico dos membros inferiores durante atividades com descarga de peso corporal (BALDON *et al*., 2011; DIERKS *et al.*, 2008; SOUZA e POWERS, 2009; POWERS, 2010).

Estudos prévios verificaram ainda que indivíduos com deficiência de amplitude de movimento para dorsiflexão do tornozelo e pronação excessiva do pé podem se beneficiar de terapias adjuvantes como mobilização articular talocrural, palmilhas ortopédicas para controle da pronação subtalar excessiva e taping patelar, desde que associados a um programa de fortalecimento muscular do quadríceps e dos rotadores laterais e extensores do quadril (AMERICAN PHYSICAL THERAPY ASSOCIATION, 2019).

O tratamento conservador se mantém como abordagem de primeira escolha no manejo de pacientes com quadros agudos e crônicos de SDFP (ROTHERMICH, *et al*, 2015). Uma revisão sistemática conduzida por Mendes et al. (2019), verificou que o tratamento pautado na prescrição de exercícios é a estratégia mais eficaz para alívio dos sintomas e melhora da capacidade funcional em pacientes com SDFP. Entretanto, apesar da comprovada eficácia do tratamento conservador no curto prazo, há relatos de

recorrência dos sintomas em 70% a 90% dos indivíduos com SDPF em médio e longo prazos (LANKHORST, 2015; FERBER *et al*. 2018).

Recentemente, a influência de fatores mais proximais como a deficiência do controle dos músculos do core vem sendo investigada como fator associado ao desenvolvimento da SDFP (LACK, et al, 2015). O core pode ser descrito como um conjunto de 29 músculos, composto pelos abdominais, diafragma, paraespinhais, glúteos e músculos do assoalho pélvico, que junto estabilizam a coluna, pelve e cadeia cinética durante movimentos funcionais (HIBBS, 2008; AKUTOTHA, 2007). A estabilidade e o adequado controle motor do core tem se mostrado essenciais para os movimentos dos membros inferiores; entretanto, quando esse sistema de estabilização não funciona adequadamente, o resultado é a distribuição de força inadequada que resulta em compressão ou cisalhamento de articulações da cadeia cinética dos membros inferiores, entre elas, a articulação femoropatelar (AKUTHOTA, 2007).

Há evidências de menor recrutamento dos músculos do core em pacientes com SDFP em resposta a uma perturbação externa (Motealleh et al. 2014). Outro estudo conduzido por Nakagawa et al. (2012), de forma semelhante, identificou que mulheres com SDFP apresentaram inclinação ipsilateral do tronco maior que os grupos controles em grande parte das angulações durante a execução de tarefas funcionais. O peso do tronco representa mais de 50% de toda a massa corporal (NAKAGAWA, 2012), de modo que se o controle neuromuscular desta região for inadequado poderá comprometer a estabilidade dinâmica e impor cargas elevadas sobre a articulação femoropatelar (ALMEIDA, 2013). Além disso, a fraqueza dos músculos do tronco somada ao padrão de mal alinhamento dos membros inferiores em pacientes com SDFP pode estar relacionada ao mal funcionamento da biomecânica patelofemoral (NAKAGAWA, 2012).

A inclinação ipsilateral do tronco tem sido associada como uma compensação do tronco no plano frontal em resposta a uma fraqueza do complexo posterolateral (CPL) do quadril (BLACKBURN e PADUA, 2009; POLLARD, et al, 2010). Acredita-se que a força e o controle neuromuscular dos músculos do tronco possam influenciar sua cinemática, e que em pacientes com SDFP essa alteração possa provocar um deslocamento do vetor de força de reação do solo para mais perto do centro articular do

quadril como uma forma de compensar a fraqueza do complexo posterolateral do quadril. As figuras 1 e 2 ilustram uma redução da demanda dessa musculatura através da mudança do centro de massa sobre o membro de apoio e consequente deslocamento do vetor de força de reação do solo para próximo ao centro da articulação coxofemoral e lateralmente à articulação do joelho, produzindo o colapso em valgo e o aumento do estresse femoropatelar (NAKAGAWA, 2012; POWERS, 2010).

Figura 1 – Valgo dinâmico do joelho

Padrão de mal alinhamento do membro inferior durante o agachamento unipodal, denominado valgo dinâmico. É possível observar excessiva adução e rotação interna do quadril, queda contralateral da pelve ao membro de apoio e inclinação ipsilateral do tronco. Essas alterações resultam no aumento do momento abdutor do joelho e podem causar aumento do estresse femoropatelar (Fonte: SANCHIS-AFONSO, 2016).

Figura 2 – Aumento do momento abdutor do joelho

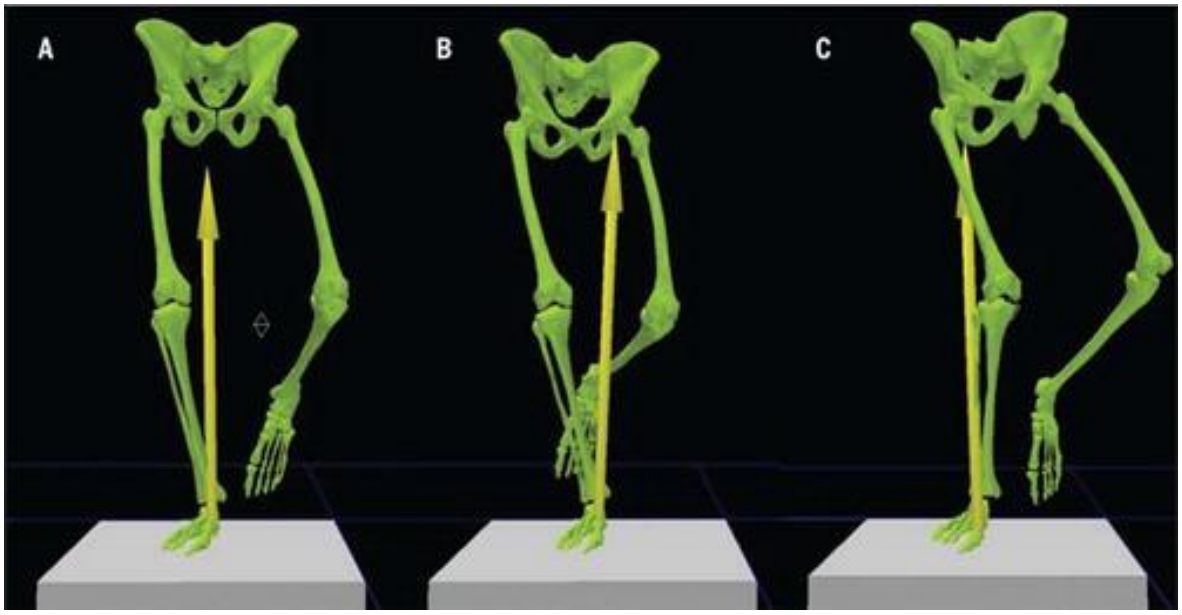

Imagem A: durante atividades com descarga de peso, o vetor de força de reação do solo normalmente passa medialmente à articulação do joelho. Imagem B: a fraqueza do complexo posterolateral (CPL) do quadril pode resultar em queda contralateral da pelve, inclinação ipsilateral do tronco e deslocamento do centro de massa para longe do membro de apoio, aumentando o momento varo do joelho. Imagem C: o deslocamento do centro de massa como resposta compensatório à fraqueza do CPL resulta na passagem do vetor de força de reação do solo lateralmente à articulação do joelho, produzindo o valgo dinâmico do joelho e consequente aumento do estresse na articulação femoropatelar (Fonte: POWERS, 2010).

Uma maior capacidade de controle neuromuscular do tronco é um componente importante para a realização de movimentos mais estáveis de tronco e pelve (NADLER, et al, 2002). Além disso, também contribui para uma fixação mais estável dos músculos do quadril (NADLER, et al, 2002), resultando em uma maior capacidade de geração do torque dos músculos rotadores laterais e extensores do quadril e promovendo melhor alinhamento dinâmico dos membros inferiores (MASCAL, et al, 2003). Programas de exercícios proximais baseados em fortalecimento dos músculos do quadril e do tronco tem se mostrado efetivos para a melhora da intensidade da dor e da capacidade funcional em pacientes com SDFP (DOLAK, *et al*, 2011; CHEVIDIKUNNAN, *et al*, 2016).

Revisões prévias corroboram a potencial eficácia do efeito da adição de fortalecimento muscular proximal ao tratamento usual em pacientes com SDFP. Uma

revisão sistemática realizada por Peter e Tyson (2013) avaliou a eficácia de programas de fortalecimento proximal em pacientes com SDFP e verificou que indivíduos que receberam exercícios terapêuticos com abordagem proximal obtiveram maior alívio na intensidade da dor e maior melhora da capacidade funcional a longo prazo. Em outra revisão sistemática realizada por Lack *et al* (2015), foi verificada melhora significativa na intensidade da dor e capacidade funcional em indivíduos que receberam fortalecimento de músculos proximais adjunto ao tratamento usual no curto, médio e longo prazo.

Apesar dessas revisões apresentarem informações clínicas relevantes, elas apresentam limitações metodológicas. Na revisão sistemática conduzida por Peter e Tyson (2013), dos oito estudos incluídos na revisão apenas três eram ensaios clínicos controlados randomizados, e apenas um estudo incluiu exercícios de fortalecimento para o tronco. Na revisão sistemática conduzida por Lack et al (2015), houve grande variabilidade no delineamento de estudos, dos protocolos aplicados e das medidas de desfecho. Além disso, a heterogeneidade da metanálise de prescrição de exercícios permaneceu alta, o que levanta o questionamento a respeito da validade dos resultados.

No exposto, é possível constatar a necessidade de atualização acerca dos efeitos adicionais do core aos cuidados usuais em pacientes com SDFP, visto que os estudos ainda são escassos e que fatores proximais, como o controle neuromuscular do tronco, parecem desempenhar papel relevante na mudança de desfechos clínicos e prognóstico desses pacientes. Deste modo, o objetivo desse estudo é verificar os efeitos da adição de exercícios para o core aos cuidados usuais na redução da intensidade da dor e na melhora da capacidade funcional em adultos com SDFP.

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ARTIGO CIENTÍFICO

ADDITIONAL EFFECTS OF CORE EXERCISE ON PAIN AND FUNCTIONAL ABILITY RELATED TO PATELLOFEMORAL PAIN: SYSTEMATIC REVIEW OF RANDOMISED CONTROLLED TRIALS

Efeitos adicionais de exercícios para o core na melhora da dor e da capacidade funcional relacionada a síndrome da dor patelofemoral: revisão sistemática de ensaios clínicos controlados randomizados

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ABSTRACT

OBJECTIVES: To evaluate the effect of adding core exercises to the usual care in adults with patellofemoral pain. **METHODS:** Allied and Complementary Medicine Database (AMED), Cochrane Library, Excerpta Medica database (Embase), Medical Literature Analysis and Retrieval System Online (MEDLINE), PSYCINFO, SPORTDISCUS, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Physiotherapy Evidence Database (PEDro) were searched. Randomized controlled trials assessing the effect of adding core exercises to usual care on pain intensity and functional ability in adults with patellofemoral pain syndrome. **RESULTS:** Five studies of moderate to high methodological quality met the inclusion criteria. There was low certainty evidence of that adding core exercises is superior to the usual care for improving pain intensity (MD = 1.93; 95% CI: 1.28 to 2.57) and functional ability (MD=6.45; 95% CI: 3.47 to 9.43) in adults with patellofemoral pain syndrome. There was limited evidence that a hip and core protocol rehabilitation was superior to a knee rehabilitation for improving pain intensity and functional ability in adults with patellofemoral pain syndrome. **CONCLUSION:** Adding core to the usual care may improve pain and functional ability in adults with patellofemoral pain compared to usual care alone in short term. PROSPERO identifier: CRD42020216189.

Keywords: Patellofemoral Pain. Knee. Rehabilitation. Physical Functional Performance.

BACKGROUND

Patellofemoral pain syndrome (PFPS) is a common knee joint disorder characterized by the presence of peri- or retropatellar pain in the anterior region of the knee. [3, 14, 24] The PFPS symptoms often arise during weight-bearing movements, such as climbing stairs and running. [3,44] The exact etiology remains unknown but factors contributing to PFPS are thought to include: muscular imbalances and abnormal hip mechanics.[3,5,11,13,32] The prevalence of PFPS ranges from 3% to 85%, being 25% the most frequently cited prevalence rate[6].

The traditional therapeutic approach recommended for patients with PFPS includes proximal, local and distal interventions. Exercise therapies are supported by level A evidence of efficacy for PFP management.[3,5,8,24]. However, despite the goods results reported for short-term effects for exercise-based treatment, it was estimated that more than 50% of individuals with PFPS will report unfavorable outcomes 5-8 years following usual care.[26]

Although the basic research supports the possible relationship between the influence of proximal factors and PFPS, previous reviews[25,40] that investigated the additional effects of core exercises on pain and disability in patients with PFPS had important methodological limitations due to the wide variability of designs, applied protocols, and outcome measures. Therefore, the aim of this systematic review was to investigate short-term and long-term effectiveness of adding core exercises to the usual care for reducing pain and disability in adults with PFPS.

METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[29,34] The protocol was prospectively registered in PROSPERO (registration number CRD42020216189).[39]

Search Strategy and Study Selection

A computer-based searched was conducted in the Cochrane Database, AMED, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, EMBASE, MEDLINE, PSYCINFO, SPORTDISCUS, CINAHL and PEDro database on September 9th 2020, and updated on August 18th 2021. The full search strategy is available in **APPENDIX A**. All records were downloaded to Endnote® X5 (Clarivate Analytics, Philadelphia, PA), where duplicates were removed. Two independent reviewers (PRMP and ADFM) screened the titles and abstracts and assessed potential full-text of potentially eligible studies. Full texts that met the eligibility criteria were included in the review. Authors were contacted via e-mail when data were not available in the published manuscript. If the authors could not provide the missing data or did not reply to the request after three attempts, the study was excluded from further quantitative analysis. The same reviewers then independently reapplied the selection criteria to full-text versions of the studies to determine eligibility. All disagreements were resolved between the 2 reviewers, with a third reviewer (MAA) available to facilitate consensus if necessary.

Eligibility Criteria

Studies were included if they met the following criteria: (1) Randomized controlled trials assessing the effect of adding core exercises to the usual care compared with the

usual care in individuals with PFPS. (2) Studies that diagnosed patients with PFPS. (3) Studies assessing pain intensity and/or disability variables using valid measures.

We included trials that recruited participants with PFPS, diagnosed in line with the current recommendations for PFPS diagnosis, using the following criteria : (1) the presence of retropatellar or peripatellar pain, (2) reproduction of retropatellar or peripatellar pain with squatting, stair climbing, prolonged sitting, or other functional activities loading the PFJ in a flexed position, and (3) exclusion of all other conditions that may cause anterior knee pain, including tibiofemoral pathologies[3].

We considered muscle strengthening, progressive exercises with loads of 60% to 70% of a repetition maximum for beginners, as recommended by the guidelines of the American College of Sports Medicine[2].

Bias and Quality Assessment

The methodologic quality and risk of bias of included studies was performed by 2 reviewers (PRMP and ADFM) using the Physiotherapy Evidence Database (PEDro) scale[30]. The PEDro scale consist of 11 items: eligibility criteria, random allocation, concealed allocation, similarity at baseline, subject blinding, therapist blinding, assessor blinding, adequate follow-up, intention-to treat analysis, between-group statistical comparison for at least one key outcome and point estimates and variability. Items are scored as either present (1) or absent (0) and a score out of 10 is obtained by summation. Based on the PEDro score, and guidance by Silva et al (2020), studies scoring > 7 were considered high quality (HQ), moderate quality (4-6/10) and low quality (3/10 or less).

The PEDro scale has intra- and inter-examiner reliability from "acceptable" to "excellent" for clinical trials of physical therapy intervention, with an intra-class correlation of 0.53-0.91. [30]

Data Extraction

Two review authors (PRMP and ADFM) independently extracted data using standardized data extraction form. The following data were extracted: trial characteristics (publication details, author and year), participant characteristics (population, age, sex and number of participants in each group), interventions description (exercises, number of series and repetitions), outcomes measures, assessment tools and follow up period. When more than one time point was available within the same follow-up period, the one closer to the end of the intervention was considere. Discrepancies were resolved by consensus or, if necessary, by a third reviewer (MAA).

Data Synthesis and Statistical Analysis

Where appropriate, meta-analysis was performed for summarizing data from studies that reported a functional ability and pain intensity score for core endurance exercises compared with the usual care alone. Qualitative analysis of all articles included risk-of-bias assessment.

We calculated the mean differences (MDs) with 95% confidence intervals (CIs) for both pooled and unpooled continuous data from the end of treatment and subsequent follow-ups, if available.

We assessed heterogeneity by visual inspection of the forest plot (analysis) along with consideration of the Chi² test for heterogeneity and the I² statistic[22]. We considered heterogeneity statistically significant if the I² statistic was 70% or more or the P value <

0.1 for the Chi² test.[22] The random effect model was used for pooled data since there was no statistical heterogeneity between the included studies. [22] Subgroup and sensitivity analyses assessed potential sources of heterogeneity: clinical categories; and methodological quality of included trials (ie, a PEDro score < 3 out of 10 was considered poor quality), using meta-regression when possible (ie, when at least 10 trials was pooled, following the Cochrane recommendations). Otherwise, qualitative subgroup analysis were conducted by different clinical categories and removing poor quality trials (ie, when less than 10 trials were pooled). The meta-analysis was performed in RevMan® 5.4 (The Nordic Cochrane Center, Copenhagen, Denmark).

RESULTS

The online database and bibliographic hand search yielded a total of 1988 studies, being of these 903 nonduplicate (**FIGURE 1**). Following title and abstract screening, fourteen studies underwent full-text review, when a further nine studies were excluded. Five studies met the eligibility criteria and were included in the qualitative synthesis.[4,15,16,35,45] Four

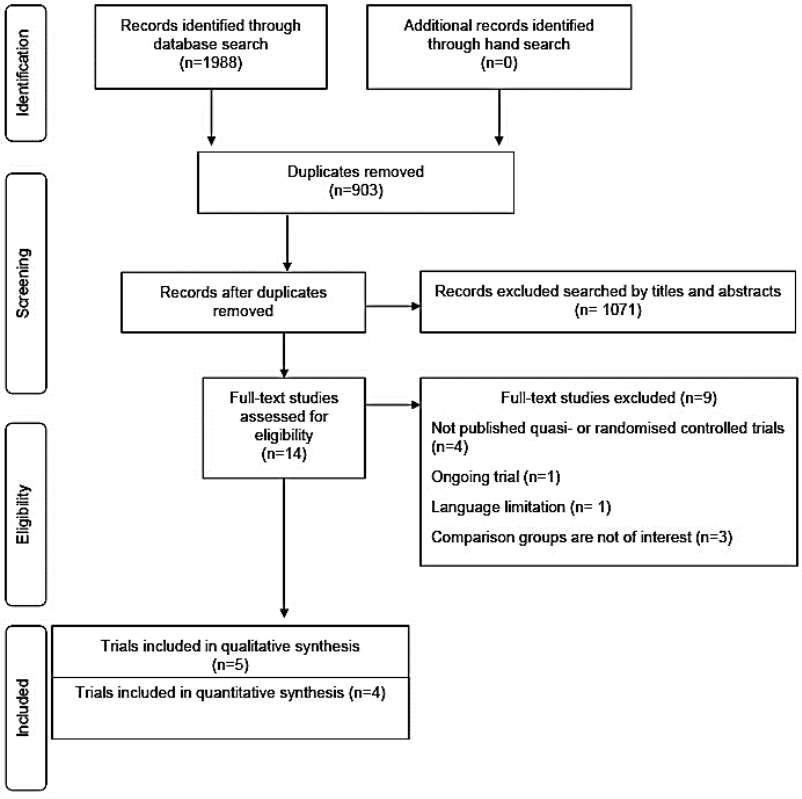


Figure 1: Flow of studies through the review

studies investigated the effects of adding core exercises to the usual care and where included in quantitative analysis.[4,16,35,45]

Participant Characteristics of Included Studies

The total sample of this systematic review consisted of 333 adults with patellofemoral pain of which 267 were female (80.1%) and 66 were male (19.8%). Of the 333 participants, 178 (53.4%) were included in the intervention group and 155 (46.5%) were included in the comparison group. Individual study sample sizes ranged from 14 to 20 participants. The mean age was of 30 years old for the intervention group and 29 years old for the control group. Two studies[45,35] recruited sedentary adults, while three studies[4,15,16] recruited adults who practiced recreational physical activity at least 3 times per week for at least 30 minutes, but not professionally.

Methodological Quality and Risk of Bias Assessment

The included studies scored moderate to high quality on PEDro scale **(FIGURE 2)**. Three studies were rated as high quality [4,15,35] and two studies[16,45] was rated as moderate quality. Almost all studies were at high risk of bias for blinding, since blinding is not easily applicable due to the nature of physical interventions. Two studies [15,35] blinded the assessor and only one study[45] blinded the therapist. The most common source of bias across studies was failure to provide adequate follow up (60%) and intention-to- treat analysis (60%). Full details of the risk of bias for the five trials are provided in **FIGURE 2.**

	1	2	3	4	5	6	7	8	9	10	11	Score
Yealvar et al. (2015)	+	+	?	+	?	+	?	-	-	+	+	5
Ferber et al. (2015)	+	+	+	+	?	?	+	-	+	+	+	7
Baldon et al. (2014)	+	+	+	+	-	-	-	+	+	+	+	7
Foroughi et al. (2018)	+	+	?	+	-	-	-	-	-	+	+	4
Motealleh et al. (2018)	+	+	+	+	?	?	+	+	-	+	+	7

FIGURA 2: Methodological quality assessment

Figure 2: Risk of bias assessment in answer to the PEDro scale: (1) Eligibility criteria; (2) Random sequence generation; (3) Concealed allocation; (4) Baseline Comparability; (5) Blinding subjects; (6) Blinding Therapists; (7) Blinding assessor; (8) Adequate follow up; (9) Intention-to-treat analysis; (10) Between-group comparisons; (11) Point estimates and variability. *This eligibility criterion does not contribute to the total score.

Studies Characteristics

Four of the five studies included in this review had a sample composed of female individuals.[4,16,35,45] Only one study[15] included individuals of both sexes. Three studies[4,16,45] performed outcome analysis immediately after treatment, with a three-month follow-up. Two studies[15,35] performed outcome analysis only immediately after treatment.

The average duration of the strength training in the included studies was 5,5 weeks with an average frequency of 3,5 days a week. The trial[15] that did not enter the meta-analysis offered daily care for a period of four weeks and the other four studies[4,16,35,45] offered care three times a week with a time interval that ranged from six to eight weeks for the total treatment time. In addition, three studies [15,35,45] delivered a home program exercises that also should be performed daily by patients. Two studies[4,16] delivered only clinic treatment with a 3 times a week frequency.

Certainty of evidence

Outcome-level certainty assessment was performed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE).[18,19,20] Two reviewers (PRMP and ADFM) performed the assessment independently, with the disagreements settled by consensus. In the current review, certainty levels started at the “high-certainty” evidence classification level and were downgraded according to the set criteria. High quality evidence was downgraded in one point for each of the following issues: imprecision when analyzed sample lower than 400;[18] risk of bias

when more than 25% of the participants where from trials with high risk of bias (PEDro score < 3 out of 10),[19] inconsistence when I^2 statistics were greater 50% or when pooling was not possible;[20] and publication bias when pooling ≥10 trials.[23]

Effect of Adding Core Exercises to the Usual Care Versus Usual Care Alone on Pain Intensity

There was low–certainty evidence that adding core exercises to the usual care improve pain intensity compared with the usual care alone, with a small effect size at short term (MD = 1.93; 95% CI: 1.28 to 2.57, *random effects*). Three of the four studies[16,35,45] included in the meta-analysis indicated that there was a statistically significant change between the groups, which suggests that adding core exercises to the usual care is effective in reduces pain in the short term. One study[4] showed a higher confidence interval and indicated that core strengthening did not significantly change pain, compared to the usual care (MD = -1.70; 95% CI: -3.42 to -0.02). There was not statistical heterogeneity (i^2=0%), indicating that the variation between de results of the studies was below the variation expected by chance.

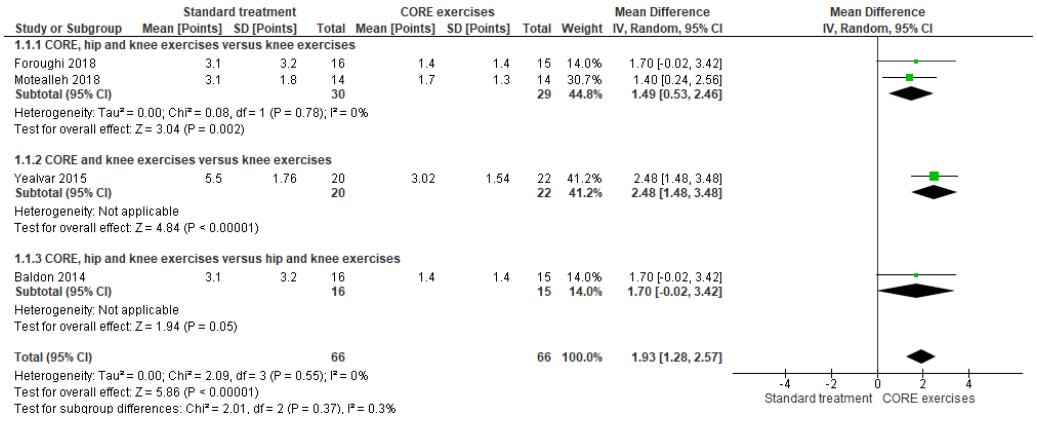
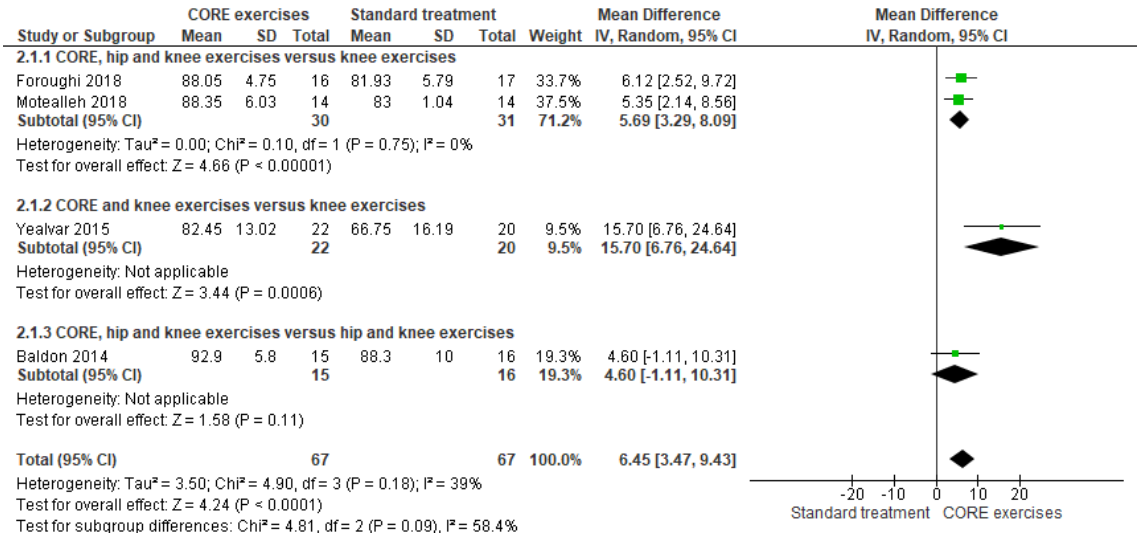


Figure 3: Meta-analyses of adding core exercises to usual care versus knee and hip strengthening alone for the outcome pain intensity. Abbreviation: SD, Standard deviation.

Effect of Adding Core Exercises to the Usual Care Versus Usual Care Alone on Functional Ability

There was low–certainty evidence that adding core exercises to the usual care improve functional ability when compared with the usual care alone, with a small effect size at short-term (MD = 6.45; 95% CI: 3.47 to 9.43). There was a statistically significant difference between the groups in three studies[16,35,45] suggesting that adding core exercises to the usual treatment significantly improved functional ability. One trial[4] found no difference between add core exercises to usual care and the usual care alone in adults with PFPS (MD = 4.60; 95% CI: -1.11 to 10.31) at short-term. There was low statistical heterogeneity (i^2 = 39%), indicating that the variation between de results of the studies was below the variation expected by chance.



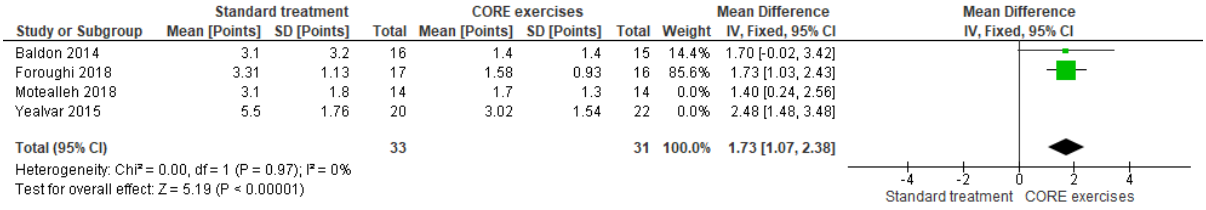
Meta-analyses of adding core exercises to usual care versus knee and hip strengthening alone for the outcome functional ability. Abbreviation: SD, Standard deviation.

Figure 4: Meta-analysis for knee pain.

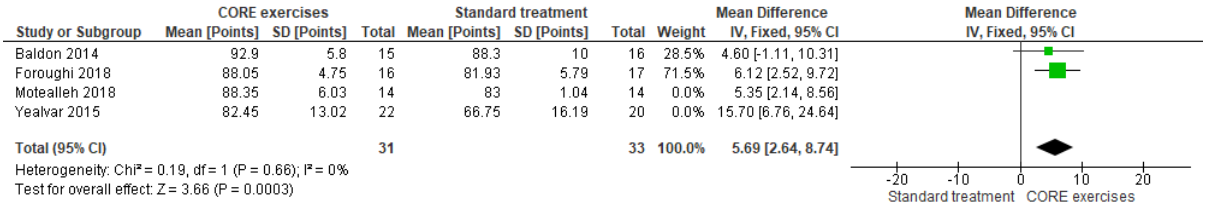
Sensitivity Analysis

Sensitivity analysis was performed to investigate the impact of interventions characteristics issues when a home exercises program was prescribed in addition to the

core exercises in the intervention group. Sensitivity analysis removing two studies[35,45] that prescribed a home exercise program suggests that there was no significant change in the effect size of pain intensity (MD = 1.73; CI 95%: 1.07 to 2.38) or functional ability (MD = 5.69; 95% CI: 2.64 to 8.74) in the short term.



Sensitivity analysis excluding studies that prescribed home exercise. Outcome: pain intensity.



Sensitivity analysis excluding studies that prescribed home exercise. Outcome: functional ability.

Figure 5: Sensitivity analysis.

DISCUSSION

The objective of this systematic review was to determine whether adding core exercises to usual care was more effective than usual care alone for pain and functional ability outcomes for adults with PFPS. Previous systematic reviews[25,40] have verified the effectiveness of proximal therapeutic exercises over reducing pain and improving the functional ability of patients with PFPS. However, this is the first systematic review to compare the effectiveness of adding core exercises to usual care with the usual care alone in patients with PFPS.

The difference between the means was 1.93 for pain intensity and 6.45 points for functional ability outcome. Therefore, the effects size for both comparisons were consider

small. This systematic review shows evidence that adding core exercises to the usual care appears to be an effective treatment compared with the usual care alone in patients with PFPS. However, due to the small amount of available studies regarding the effectiveness of the core exercises to treat patients with PFPS, the results should be interpreted with caution.

Previous studies reported a minimal clinically important difference (MCID) between 1.1 and 3 points for the Numeric Pain Rating Scale (NPRS) and Visual Analogue Scale (VAS).[21,27,42] Our results suggest that adding core exercises to the usual care is more effective than usual care alone to improve pain intensity. People with PFPS may benefit from core exercise because of the positive effect on neuromuscular control of the trunk, that improve lower limbs muscles performance and consequently reduces internal peak knee abduction moments and patellofemoral overload.[25,31]

Another plausible explanation for pain intensity reduction is the analgesic effect induced by the exercises that occurs through central or systemic mechanisms, termed exercises-induced hypoalgesia (EIH).[43] The fact that PFPS is a condition of multifactorial etiology also allows the improvement in clinical outcomes to be attributed not only to a specific factor, but to a combination of many factors that act synergistically, such as global changes in lower limb strength, changes in modulation of pain at the central nervous system level and also in the lower limbs biomechanics.[12,25]

The effect size greater than 6 points found in this review indicates a small effect of adding core exercises to usual care on functional ability.[14] This result is superior to those found by Lack et al (2015)[25] who investigated the addition of proximal exercises compared to quadriceps strengthening alone. Although guidelines endorse proximal exercises as a

level 1 evidence of efficacy, it seems like core endurance exercises may be critical for PFPS management. The hypothesis is that an adequate activation of the core muscles can reduce the disturbance during functional activities[35] and decrease the variability of knee joint movement and internal peak knee abduction moments.[25] In turn, a good control and coordination of the trunk act as a stable base for functional activities.[35] Further high-quality studies will be able to confirm these results.

Implications for practice

We found low certainty evidence of effectiveness of adding core exercises to the usual care in patients with PFPS. Thus, we emphasize that the results must be interpreted cautiously. A trunk assessment in individuals with PFPS must be considered, since modifiable factors such as the influence of the trunk on PFPS symptoms can contribute to a better prognosis of these individuals. None of the studies reported long-term outcomes, wich would be important to consider for patients with PFPS. Therefore, future studies should investigate maintenance of the benefits of therapy in the medium and long term.

We suggest studies of higher methodological quality and based in more representative samples in order to raise certainty around evidence. Additionally, future studies should investigate whether there is potential variation in the effects of therapy between different types of exercise and/or populations (sedentary and athletes, for example). This may contribute to a more assertive recommendation for intervention, centered on the individual demands of each patient.

Core exercises are not mentioned in recent clinical practice guidelines for patellofemoral pain syndrome. We suggest that future guidelines consider the role of core

exercises in the context of treating patients with patellofemoral pain. However, we reinforce the need for more randomized controlled trials of high methodological quality to reduce the uncertainty surrounding the available evidence.

Limitations

Our low certainty results from the evidence that adding core exercises to usual care is superior to usual care alone is due to the small sample size and consequent risk of statistical imprecision. This means that, despite the promising results, studies are still scarce and more research are needed to determine whether adding exercises to the core actually changes clinical outcomes in patients with PFPS.

The non-standardization of the assessment instruments and applied protocols is a barrier to the implementation of basic endurance exercises for patients with PFPS. The description of applied loads was insufficient for replication of the protocols, two studies[33,43] did not report the applied load or how the load progression was performed. For this, we recommend that future studies use the Template for Intervention Description and Replication (TIDIeR)[10]. This will allow for enough detail to allow replication of interventions.

CONCLUSION

Core exercises in adjunct to usual care produced better results in reducing pain intensity and improving functional ability in adults with PFPS in the short term.

IMPLICATIONS

The addition of core endurance exercises to the usual care provided more beneficial results in pain intensity and functional ability outcomes when compared with the usual

care alone. This suggest that health professionals should evaluate the trunk of patients with PFPS in order to positively influence clinical outcomes and patient's prognosis.

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APPENDIX A - Search strategy conducted on september 9th 2020

OVID (AMED - Allied and Complementary Medicine, COCHRANE Central Register of Controlled Trials, COCHRANE Database of Systematic Reviews, EMBASE, MEDLINE, PSYCINFO)

1. Randomized Controlled Trial/
2. Controlled Clinical Trial/
3. randomized controlled trial$.mp.
4. randomised controlled trial$.mp.
5. controlled clinical trial$.mp.
6. random allocation.mp. or Random Allocation/
7. Clinical Trial/
8. clinical trial$.mp.
9. Comparative Study/
10. cross-over studies.mp. or Cross-Over Studies/
11. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
12. Patellofemoral pain syndrome.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
13. Patellofemoral joint.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
14. Anterior knee pain.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
15. Chondromalacia Patellae.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
16. femoro-patell*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
17. retropatell*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
18. peripatell*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
19. chondromalac*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
20. chondropath*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
21. Patellofemoral pain.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
22. femoropatell*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
23. 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22
24. exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
25. strength*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
26. resistance training.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]

27. weight training.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
28. strength training.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
29. resistance exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
30. core exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
31. trunk exercise*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
32. stabilit*.mp. [mp=ab, hw, kw, ti, ot, sh, tx, ct, tn, dm, mf, dv, fx, dq, nm, kf, ox, px, rx, an, ui, sy, tc, id, tm, mh]
33. 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32
34. 11 and 23 and 33

EBSCO (SPORTDISCUS and CINAHL)

S1. (((femoropatell* pain) OR (Anterior knee pain) OR (Patellofemoral pain))) AND (((randomized controlled trial*) OR (randomised controlled trial*) OR (clinical trial*) OR (random allocation) OR (comparative stud*) OR (crossover stud*)))

PEDro

Abstract & Title: Patellofemoral pain
Therapy: not applicable
Problem: not applicable
Body Part: lower leg or knee
Subdiscipline: musculoskeletal
Topic: not applicable
Method: clinical trial
Author/Association: not applicable
Title Only: not applicable
Source: not applicable
Published Since: not applicable
New records added since: not applicable
Score of at least: not applicable

APPENDIX B - PICOT definition

Table 1 – PICOT defenition	
Participants	Adults with patellofemoral pain
Intervention	Core, hip and knee exercises
Comparator	Hip and/or knee exercises
Outcome	Pain and physical function
Time point	Short term

APPENDIX C - Grade Ratings

CORE exercises in addition to the usual care *versus* the usual care alone in patients with patellofemoral pain

Certainty assessment							№ de pacientes		Efeito		Certainty	Importância
№ dos estudos	Delineamento do estudo	Risco de viés	Inconsistência	Evidência indireta	Imprecisão	Outras considerações	CORE plus usual care	usual care alone	Relativo (95% CI)	Absoluto (95% CI)		
Pain intensity immediately after treatment (seguimento: média 5,5 semanas; avaliado com: Scales ranging from 0 to 10 points)												
4	ensaios clínicos randomizados	grave [a,b]	não grave	não grave	grave	nenhum	67	67	-	MD **1.85 menor** (2.34 menor para 1.35 menor)	⨁⨁◯◯ BAIXA	CRÍTICO
Physical function immediately after treatment (seguimento: média 5,5 semanas; avaliado com: Scales ranging from 0 to 100 points)												
4	ensaios clínicos randomizados	grave [a,b]	não grave	não grave	grave [c]	nenhum	67	67	-	MD **6.11 menor** (8.26 menor para 3.97 menor)	⨁⨁◯◯ BAIXA	CRÍTICO

CI: Confidence interval; **MD:** Mean difference

Explanations

a. Motealleh and Piva trial did not perform blinding (of subjects, assessors or therapists).
b. Motalleh did not perform adequate follow up and intetion-to-treat analysis.
c. The total number of participants in this comparison is lower than the Optimal Information Size.

Abbreviation: GRADE, Grading of Recommendations Assessment, Development and Evaluation.

APPENDIX D - Studies Characteristics

Study	Population	Participants	Intervention group	Control group	Treatment time
Atay et al (2015)	Sedentary Adults	Women, n = 42 Age (control group), 45.50±5.52 Age (intervention group), 45.41±4.39	Core and hip exercises	Knee exercises	Six weeks
Ebrahimi et al (2018)	Sedentary Adults	Women, n = 28 Age (control group), 30.42± 6.13 Age (intervention group), 28.35±5.67	Core, hip and knee exercises	Knee exercises	Four weeks
Ferber et al (2015)	Adult recreational activities	Women, n = 133 (66.8%) Men, n = 66 (33.2%) Age, 29.0 ± 7.1 y	Core and hip exercises	Knee exercises	Six weeks

Motealleh et al (2018)	Adult recreational activities	Women, n = 33 Age (control group), 23.75±1.73 Age (intervention group), 23.41±2.39	Core, hip and knee exercises	Hip and Knee exercises	Four weeks
Piva et al (2014)	Adult recreational activities	Women, n = 31 Age (control group), 21.3±2.6 Age (intervention group), 22.7±3.2	Core, hip and knee exercises	Hip and Knee exercises	Eight weeks

APPENDIX E - Exercises Dosage and Intervention Details

Study	Session duration (min)	Frequency (n per week)	Sessions, n	Intervention
Atay et al (2015)	Not reported	3	18	Knee and core protocol *versus* a knee protocol
Ebrahimi et al (2018)	21	5	20	Core, hip and knee protocol *versus* a knee protocol
Ferber et al (2015)	Not reported	3	18	Core and hip protocol *versus* a knee protocol

Motealleh et al (2018)	45 min	3	12	Core, hip and knee protocol *versus* a hip and knee protocol
Piva et al (2014)	90 min	3	24	Core, hip and knee protocol *versus* a hip and knee protocol

ANNEX A – Manuscript Preparation

GUIDE FOR AUTHORS

Your Paper Your Way

We now differentiate between the requirements for new and revised submissions. You may choose to submit your manuscript as a single Word or PDF file to be used in the refereeing process. Only when your paper is at the revision stage, will you be requested to put your paper in to a 'correct format' for acceptance and provide the items required for the publication of your article.
To find out more, please visit the Preparation section below.

Types of paper

Original Research: Provide a full length account of original research and will not normally exceed 4000 words.
Review Papers: Provide an in-depth and up to date critical review of a related topic and will not normally exceed 4000 words.
Case Studies: A case report providing clinical findings, management and outcome with reference to related literature.
Masterclasses: Usually a commissioned piece by an expert in their field. If you would like to submit a non-commissioned article, please check with the editorial office beforehand. Please note Masterclass articles should be submitted as "Feature Article" on the Editorial system

These word counts include Keywords and the references contained within the article. The reference list at the end of the article, the Abstract, figures/tables, title and author information and Appendices are not included in the word count.

BEFORE YOU BEGIN

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New guidance for randomised controlled trials

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Articular cartilage is a unique biphasic material that supports a lifetime of compressive and shear forces across joints. When articular cartilage deteriorates, whether due to injury, wear and tear or normal aging, osteoarthritis and resultant pain can ensue. Understanding the basic science of the structure and biomechanics of articular cartilage can help clinicians guide their patients to appropriate activity and loading choices. The purpose of this article is to examine how articular cartilage structure and mechanics, may interact with risk factors to contribute to OA and how this interaction provides guidelines for intervention choices This paper will review the microstructure of articular cartilage, its mechanical properties and link this information to clinical decision making.

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